Health Consultation

Evaluation of Sample Data from Sutton Branch and Big Creek

ANNAPOLIS LEAD MINE
ANNAPOLIS, IRON COUNTY, MISSOURI

EPA FACILITY ID: MO0000958611

NOVEMBER 16, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Missouri Department of Health and Senior Services
Division of Community and Public Health
Bureau of Environmental Epidemiology
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Statement of Issues

On September 7, 2006, the Missouri Department of Health and Senior Services (DHSS), in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR), completed a Public Health Assessment for the Annapolis Lead Mine (ALM) in Annapolis, Missouri at the request of the U.S. Environmental Protection Agency (EPA). In the Public Health Assessment, DHSS recommended the testing of downstream sediment of Sutton Branch and Big Creek to assess the impact of materials transported downstream from the ALM. EPA has completed the testing of these sediments.

DHSS, in cooperation with ATSDR, has completed this health consultation at the request of EPA to review and comment on the environmental data collected as part of the sediment evaluation of Sutton Branch and Big Creek. This health consultation addresses the public health implications of the evaluation's findings and makes recommendations to reduce exposure to site-related contaminants.

Background

Throughout most of its history, the State of Missouri has been the top producer of lead in the country. Deposits of lead ore have been discovered and mined in many of Missouri's counties south of the Missouri River. In many locations these lead deposits occurred at or near the surface. Much of the southeastern and southwestern parts of the state have been mined for lead or related minerals at some time in the past, often leaving behind elevated levels of lead and other mining related contaminants. Over time, these contaminants can move to residential areas due to wind or water erosion or from human activities such as using mine wastes as fill material in yards or driveways. In other instances, residential development has expanded into areas that were previously mined.

One such area is the Annapolis Lead Mine (ALM) site, an inactive lead mine located in Iron County, Missouri, approximately one mile east of the town of Annapolis. Lead mining began at the site in 1919 and continued sporadically until 1940. Since 1919, several companies have owned the Annapolis mine, mining operations and associated mineral rights. See Figure 1 for a map of the site area.

The Annapolis Lead Company reportedly owned/operated the mine at the site from 1919 until 1931. Production figures indicated that approximately 1,173,000 tons of mining wastes were generated during this time period (1). The Ozark Lead Mining Corporation owned the property from 1931 until 1941, but only conducted mining activities from 1938 to 1940. It appears that no mining activities took place on-site after that time. Since 1987, the Doe Run Company has owned the mineral rights. Currently, the site property is divided into parcels and owned independently by individual citizens. One family lived on the property sporadically in one of the former mine buildings, and another family had at one time planned to reside on-site. At this time, the on-site structures are uninhabited.

During the time the ALM was in operation, ores were excavated, crushed, concentrated and stored on site prior to offsite shipment for smelting (1). The mining process created waste

materials called tailings that are the size of sand and are contaminated with lead. The crushed, lead-contaminated wastes (tailings) were disposed of in a ravine on the property that is a tributary of Sutton Branch Creek. The resulting pile of tailings was highly erodible, having steep sides and an outwash area that fanned westward towards and into Sutton Branch. At one time, the sediment in Sutton Branch immediately downstream of the ALM site was almost entirely tailings. See Figure 2.

Sutton Branch flows approximately 4500 feet from the ALM site before joining Big Creek (2) (Figure 1). Sutton Branch is classified as an intermittent stream, which may pond in low areas during periods when the stream is not flowing (2, 3). These ponds allow small bass and pan fish, pickerel, darters, minnows and crayfish to live in Sutton Branch during periods of low or no flow as observed by EPA and DHSS personnel on October 10, 2006 during a site visit.

The terrain around Sutton Branch below the ALM site is very rough and densely vegetated. There is very little sign of human activity or recreational use in this stretch of stream. There is, however, one residence located near the bank of Sutton Branch at the Highway 49 Bridge where the stream is more accessible.

To prevent the continuing erosion of lead containing tailings from the ALM site into Sutton Branch, EPA has completed a time-critical removal action at the ALM site. This activity has consolidated the tailings on site and covered (capped) the tailings with 18 inches of uncontaminated soil. As a result, the migration of tailings from the site has been greatly reduced. The EPA and Missouri Department of Natural Resources (MDNR) are working on promoting vegetative growth covering the ALM site to prevent erosion of the cap material into Sutton Branch. EPA has placed rocks around the tailings pile to further reduce erosion.

In the past, lead levels found in the soil and drinking water in and around the ALM exceeded lead action levels for soil and for drinking water (4). Residents, especially children, were at risk for adverse health effects. The children who resided on-site did have elevated blood lead levels. However, there are no longer residents living on-site. The pile has been capped to contain the tailings. Exposure to the on-site lead contaminated tailings has been significantly reduced or eliminated by the time-critical removal action and physical restrictions.

Two US Fish and Wildlife Service (USFWS) studies were conducted on aquatic life in Big Creek in 1993 and 1997. Both studies showed heavy metal contamination in fish species. In fact, there is still a problem with lead contamination in Big Creek in Iron County. There is currently a fish advisory for sunfish and bottom feeding fish in Big Creek upstream of the ALM site near a currently inactive lead smelter in Glover, Missouri. These fish have been found to contain lead at levels of health concern and should not be eaten (4).

The 1993 study indicated that the fish at the site location downstream of the confluence of Big Creek and Sutton Branch Creek had blood lead concentrations significantly greater than an upstream site location of Big Creek. According to the 1997 report, sampling indicated that fish were accumulating lead in Big Creek, and that concentrations in fish were increasing. The study noted the ALM site as a probable source of contaminants in fish and suggested continued monitoring (4).

Further information on ALM and test results can be found in the Public Health Assessment of the Annapolis Lead Mine (4).

Site Investigations

In January 2006, EPA began collecting sediment samples starting at the ALM site on Sutton Branch Creek and continuing downstream to its mouth at Big Creek, and along Big Creek to where it joins the St. Francis River. In Sutton Branch, because water levels are low, EPA collected sediment samples throughout the streambed. In the larger Big Creek, sediment samples were collected from the bank of the river and from pools where water moves slower and small particles like tailings are more likely to settle to the bottom. Sediment samples were tested for 24 metals, which found lead and zinc to be the contaminants of most concern.

Sampling results showed a concentration of 5,290 parts per million (ppm) of lead in the sediments where the ALM drains into Sutton Branch. A short distance downstream in a pool of water a lead concentration of 5,330 ppm was observed in sediment sampling. Levels of lead progressively decreased in concentration downstream in Sutton Branch to a level of 164 ppm, with most of the contamination occurring above the Highway 49 Bridge (See Table 1 and Figure 1). One sample from Big Creek was 520 ppm of lead, but all the other sediment samples in Big Creek were below 100 ppm (Table 1).

The highest concentration of zinc in the sediment of Sutton Branch was 1,520 ppm where the ALM drains into Sutton Branch. All the other sediment samples ranged from 288 ppm to less than 50 ppm. See Table 1.

Table 1
Contaminants Detected in Sediment In Sutton Branch and Big Creek
In parts per million (ppm)

Location	Maximum Lead Concentration	Average Lead Concentration	Maximum Zinc Concentration	Average Zinc Concentration
Point of entry where ALM drains into Sutton Branch	5,290	NA	1,520	NA
Sutton Branch from just below the ALM to Big Creek	5,330	866	288	67*
Sutton Branch adjacent to home at the Hwy. 49 bridge.	1,830	656	61	52*
Big Creek immediately downstream of Sutton Branch	520	71*	<50	50*
Big Creek from Hwy. 49 bridge to St. Francois River	72	38*	172	71*

< = The true concentration is less than the given value, but the exact concentration is not known. The value given after the "<" sign indicates the lowest concentration that the laboratory can reliably detect; this value is known as the Method Detection Limit.

* = Where the exact concentration could not be detected because it was below the Method Detection Limit, the average concentrations were calculated conservatively using the Method Detection Limit value, which is higher than the true concentration.

NA = Not applicable. Because only one sample was collected at this point, an average is not appropriate.

TOXICOLOGICAL EVALUATION

This section will describe what is known, and what is not known, about environmental exposures to the ALM site-related chemicals lead and zinc. An outline of possible health effects will be presented, and the likelihood of the contaminants causing cancer will be evaluated.

ATSDR has developed comparison values (CVs) that are media-specific concentrations used by health assessors to select environmental contaminants of concern. Contaminant concentrations that are less than the CV are unlikely to pose a health threat. Contaminant levels above the CV do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathways is needed. Environmental media evaluation guides (EMEGs) are CVs that have been derived for a variety of chemicals in various media. EMEGs can be derived for acute, intermediate, and chronic duration exposures. Acute exposure is defined as exposure that occurs for 14 days or less. Intermediate exposure occurs for more than 14 days but less than 365 days. Chronic exposure occurs for more than 365 days.

Zinc

The zinc Chronic EMEG for a child is 20,000 ppm. A Chronic EMEG for zinc is an estimate of a daily human exposure to zinc lasting longer than a year that is likely to be without an appreciable risk for noncarcinogenic effects. The highest concentration of zinc found in Sutton Branch was 1,520 ppm, which is well below the Chronic EMEG for a child.

Children who exhibit pica behaviors, having a craving to put non-food items in their mouth or eat non-food items, such as dirt, paint chips, sand, etc., may be at a greater risk of becoming exposed to contaminants in soil or sediment than other children. The zinc Intermediate EMEG for a pica child is 600 ppm. Only one sample in Sutton Branch was above this level, while all average concentrations are well below this level. See discussion on pica behaviors below in the Children's Health section.

Based on EPA's 2005 cancer assessment guidelines, there is inadequate information to assess the potential of zinc to cause cancer. Similarly, the cancer-causing potential of zinc is not classified by the National Toxicity Program; in fact, zinc is an essential element needed by the body in small amounts.

Lead

Lead is a naturally occurring metal found in the earth's crust (5). It has no characteristic taste or smell (5). It is mined and processed for use in various industries. The practice of depositing mine tailings above ground has made a large volume of lead more accessible to people. Lead is used in some types of batteries, ammunition, ceramic glazes, medical equipment, scientific equipment, and military equipment (5). An individual can be exposed to lead through other sources such as drinking water, lead paint, and other items containing lead including certain toys, jewelry, herbal remedies, Mexican candies, water hoses, and others. At one time, lead was used as an additive in gasoline and in paint. Lead from gasoline was released into the air in

automotive exhaust and deposited along roadways (5). Houses built before 1978 may contain lead based paint. Lead in the soils in the inner cities is often attributable lead based paint and leaded gasoline (5).

Lead has no nutritional benefits for humans. Exposure to lead can occur by inhalation or ingestion. Lead is not readily absorbed through the skin, so dermal contact is not an important route of exposure (5).

Studies have shown that there is a definite correlation between concentrations of lead in soils and blood lead levels in children. In general, blood lead levels increase as the lead concentrations in soil and dust increase. As blood lead levels increase, the likelihood of adverse health effects also increases. Lead has the greatest effect on the nervous system, especially in children. Examples of adverse health effects of children exposed to lead include learning difficulties and behavioral problems. Pregnant women can experience complications with their pregnancy ranging from low birth rate to miscarriage if exposed to high concentrations of lead. (5)

Health assessors typically use media-specific comparison values (CVs) developed by ATSDR or EPA to select environmental contaminants of concern. However, ATSDR and EPA have not developed a CV for ingestion of lead through soil in residential yards or sediment. Therefore, the usual approach of estimating human exposure to an environmental contaminant and then comparing this dose to a health guideline, or CV, cannot be used. Instead, exposure to lead is evaluated by using a biological model that predicts a blood lead concentration that would result from exposure to environmental lead contamination. The modeled blood lead concentration is then compared to the level of concern for blood lead concentrations in children as recommended by the Centers for Disease Control and Prevention (CDC) (CDC, 2005). CDC's current level of concern is10 micrograms of lead per deciliter of blood (10 µg/dL). (8) Using this model, EPA has established a standard cleanup value of 400 parts per million (ppm) for lead in residential yard soil using the default parameters in this model (9). The default parameters in the model include many estimated values such as estimated soil ingestion and time spent outdoors. If the default parameters are found to not be accurate in an area being investigated, the cleanup value used at that site may be different. Several parameters used to estimate exposure in residential yards are different from what is observed at Sutton Branch. For example, individuals are not likely to spend as much time in Sutton Branch as what is estimated individuals spend in their yards.

EPA has remediated Sutton Branch to be protective of possible future exposures, to prevent contamination of areas down stream with more usage, and to protect the environment. Confirmatory samples have not been taken at this point to determine current lead concentrations in Sutton Branch; however, EPA has plans to begin sample collection for this purpose in the near future. It is expected that lead concentrations in Sutton Branch have been greatly reduced by EPA's actions thus far. See Figure 2.

Cancer

While the EPA considers lead to be a probable human carcinogen and the National Toxicity Program (NTP) has determined that lead and lead compounds are reasonably anticipated to be

human carcinogens, there have been no studies linking residential ingestion of lead contaminated soil or drinking water with an increase cancer risk (5, 6). Although the American Cancer Society estimates less than half of men and slightly more than a third of women in the United States will develop some form of cancer in their lifetime, the primary health concern for lead in Sutton Branch is not cancer; instead, the primary concern from exposure to lead in Sutton Branch is the effects lead has on the nervous system, especially on children less than 72 months of age (7).

Children's Health

Children are more susceptible to lead poisoning than adults, and children are also more likely to be exposed to lead contaminated materials. Infants and young children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. Also, compared to adults, a larger proportion of the amount of lead swallowed will enter the blood in children (5). While about 99% of the amount of lead taken into the body of an adult will leave as waste within a few weeks, only about 32% of lead taken into the body of a child will leave as waste (5). All of these factors result in children being more affected by lead than adults when they have similar lead concentrations in their environment.

When children are exposed to lead contaminated materials, a variety of adverse health effects can occur depending on the amount of lead to which they are exposed and the duration of exposure. These effects include learning disabilities, slowed growth, hyperactivity, impaired hearing, and at very high exposure levels, even brain damage (5). Lead has the greatest effect on the nervous system, especially in children. In children, low levels of lead can cause weakness in fingers, wrists, or ankles. Unborn children can also be exposed to lead through their mothers and are at risk of premature births, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children (5).

Yearly blood-lead testing before a child is 72 months old is key to determining if the child has been exposed to lead. Eliminating exposure pathways by controlling contamination sources, practicing good personal hygiene, and eating a proper diet high in calcium can reduce the risk of lead poisoning in children.

Children who exhibit pica behaviors may be at an even greater risk of becoming exposed to contaminants in soil than other children. Individuals who exhibit pica behaviors have a craving to put non-food items in their mouth or eat non-food items, such as dirt, paint chips, sand, etc. Children exhibiting pica behavior may be more likely to experience adverse health effects from lead found in the soil.

DISCUSSION

Sutton Branch is contaminated with lead and to a lesser extent, zinc. The highest concentration of zinc in the sediment of Sutton Branch was 1,520 ppm where the ALM drains into Sutton Branch. However, this was the only sediment sample location that showed zinc above a comparison value. It is not likely that a person would be exposed to zinc in sediment at just one location in Sutton Branch, but would instead come into contact with a larger area of the stream.

This exposure is better represented by the average level of zinc, which is well below any comparison value, even for a child that exhibits pica behavior. Therefore, no adverse health effects are expected from zinc in Sutton Branch.

The pathway of concern in Sutton Branch is ingestion of lead-contaminated sediment and tailings by residents and visitors, especially children. However, the amount of exposure to contaminated sediments is expected to be minimal since Sutton Branch is small with little access for and playing. The area with the highest lead concentrations was found along Sutton Branch between the Highway 49 Bridge and the ALM site. This area has dense vegetation, rough terrain, and very little sign of human activity.

One area on Sutton Branch that is easily accessible is next to a residential yard near the Highway 49 Bridge over Sutton Branch is approximately ¼ mile from the ALM site. Concentrations of lead in sediment in Sutton Branch adjacent to this home are decreased from the maximum levels found upstream to an average of 656 ppm near this home. The concentration of lead detected in this section of Sutton Branch was above EPA's standard cleanup levels for soil. Residents are less likely to spend as much time in the stream as in other areas of the yard; therefore, the standard cleanup level for yard soil would not necessarily apply. However, because this residence has easier access to Sutton Branch, exposure to lead contaminants in Sutton Branch was more likely at this point than other sections of the stream.

Recently, EPA remediated Sutton Branch by removing contaminated tailings in pools in Sutton Branch in areas found to have high concentrations of lead. See Figure 2. To ensure the protectiveness of this action, EPA plans to sample sediment for lead every six months to a year. If these actions do not decrease lead levels in Sutton Branch and Big Creek, EPA will do further removal of contaminants.

One sample from Big Creek near Sutton Branch was found to contain lead at 520 ppm in sediment at the bank of the creek. Individuals are more likely to be exposed to bank sediment as opposed to sediment in deep stream pools. However, this was the only sample collected on Big Creek with an elevated lead concentration. Lead levels downstream in Big Creek quickly diminish below levels of concern. The average level of lead in Big Creek sediments immediately downstream of the confluence with Sutton Branch was found to be only 71 ppm.

Because Sutton Branch has a low volume of water and does not support larger game fish species, the amount of animals (for example, fish or crayfish) harvested and eaten out of Sutton Branch is not expected to be substantial. However, Big Creek near Sutton Branch does support the larger game fish species, which are more likely to be harvested for human consumption. In addition, two fish tissue studies conducted by the USFWS showed an increasing level of lead contamination in fish in Big Creek near the ALM site. However, these studies focused on fish blood lead concentrations, not on lead concentrations in edible portions of fish such as fish fillet tissue. A definitive conclusion about exposure to lead in fish cannot be made without such data. Also, it is not known what effect remedial actions at the ALM site have had on contaminant levels in fish in Big Creek or Sutton Branch.

CONCLUSIONS

Levels of lead in the sediment of Sutton Branch from the Highway 49 Bridge upstream to the ALM site were above levels of health concern. In the past, individuals could have been exposed to lead contamination from the ALM site itself, and could have had additional exposure to lead contamination from Sutton Branch sediments. In fact, at one time, the sediment in Sutton Branch immediately downstream of the ALM site was almost entirely tailings. Because of these two possible exposures, Sutton Branch is considered a *Public Health Hazard* for past exposures. A site that is classified as a public health hazard poses a health risk as a result of long-term exposures to hazardous substances.

EPA has completed a time-critical removal action at the ALM site. This activity has consolidated the tailings on site and covered (capped) the tailings with 18 inches of uncontaminated soil. In addition, EPA has recently completed a removal action in Sutton Branch by removing contaminated sediment from the streambed. This effort should reasonably have reduced lead contamination below a level of health concern. Because of EPA's actions, and because this area is not an attractive recreation area and there is currently no evidence that it is frequently used, especially by children less than 72 months of age, exposure to lead contaminated sediment in Sutton Branch is expected to be minimal. Therefore, Sutton Branch is considered *No Apparent Public Health Hazard* for current and future exposures. This category is used for sites where exposure to contaminated media may be occurring, but the exposure is not expected to cause adverse health effects. This category is based on the following conclusions:

1. Lead was in the sediment of Sutton Branch above a level of health concern; however, removal actions completed by EPA at the ALM site and in Sutton Branch have removed or reduced lead contamination below a level of health concern.

2. Actions taken by EPA to cap the ALM tailings pile will prevent recontamination of Sutton Branch.

The level of lead contamination in blood of fish in Big Creek has been shown in previous investigations to be increasing over time. However, fish fillet data are not available for Big Creek near Sutton Branch and the ALM site. Fish fillet sample data are preferred to assess exposure hazards from fish consumption. Therefore, consumption of fish and other stream animals from Big Creek near Sutton Branch and the ALM site are considered an *Indeterminate Public Health Hazard*. This category is used when critical information is lacking to support a judgment regarding the level of public health hazard.

RECOMMENDATIONS

1. DHSS recommends EPA collect sediment samples in Sutton Branch after remediation efforts are complete to confirm that lead contamination has been removed or reduced below a level of health concern. In addition DHSS recommends that EPA follow through

with their plans to monitor Sutton Branch for contaminants in sediment to verify that levels do not increase and reassess hazards if levels do increase.

2. DHSS recommends sampling of fish from Sutton Branch and Big Creek to test for heavy metal accumulation. In particular, fish fillet samples should be collected to assess lead exposure hazards from consumption of fish.

PUBLIC HEALTH ACTION PLAN

This Public Health Action Plan (PHAP) for Sutton Branch contains an explanation of the actions to be taken by the Missouri Department of Health and Senior Services (DHSS), the Agency for Toxic Substances and Disease Registry (ATSDR), and other stakeholders. The purpose of the PHAP is to ensure that this public health consultation not only identifies public health hazards, but provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and future exposures to hazardous substances at or near the site. Below is a list of commitments of public health actions to be implemented by DHSS, ATSDR, or other stakeholders at the site:

1. DHSS/ATSDR will review additional sampling data as it becomes available and provide guidance regarding possible health risk if necessary.

2. DHSS/ATSDR will address community health concerns and questions as they arise.

3. DHSS/ATSDR will provide health education and literature when requested.

CERTIFICATION

The Missouri Department of Health and Senior Services (DHSS) prepared this Annapolis, Iron County, Missouri Health Consultation under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the health consultation were initiated. The Cooperative Agreement partner completed the editorial review.

Technical Project Officer, CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Team Lead, CAT, CAPEB, DHAC, ATSDR

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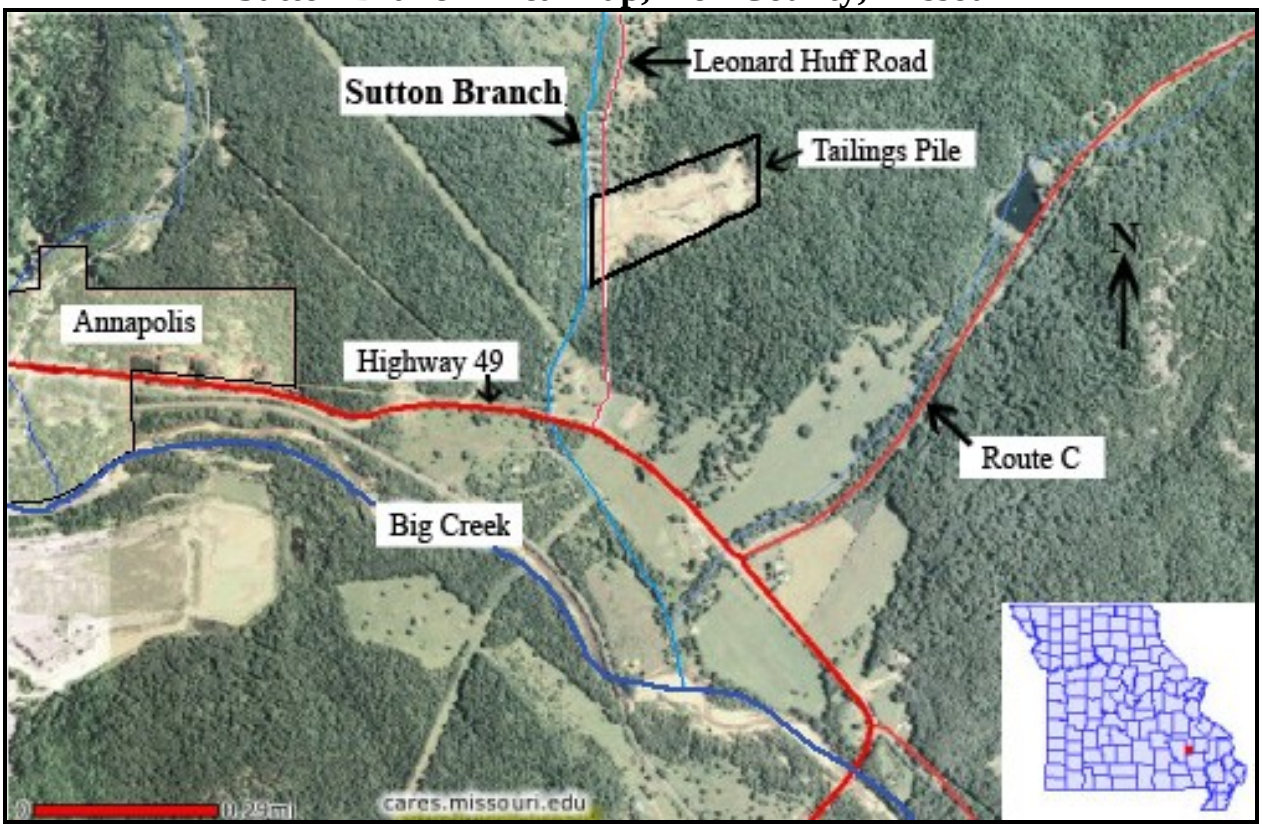
Attachments:

Figure 1: Sutton Branch Area Map, Iron County, Missouri
Figure 2: Before and after EPA remediation actions pictures of Sutton Branch, Iron County, Missouri

Figure 1

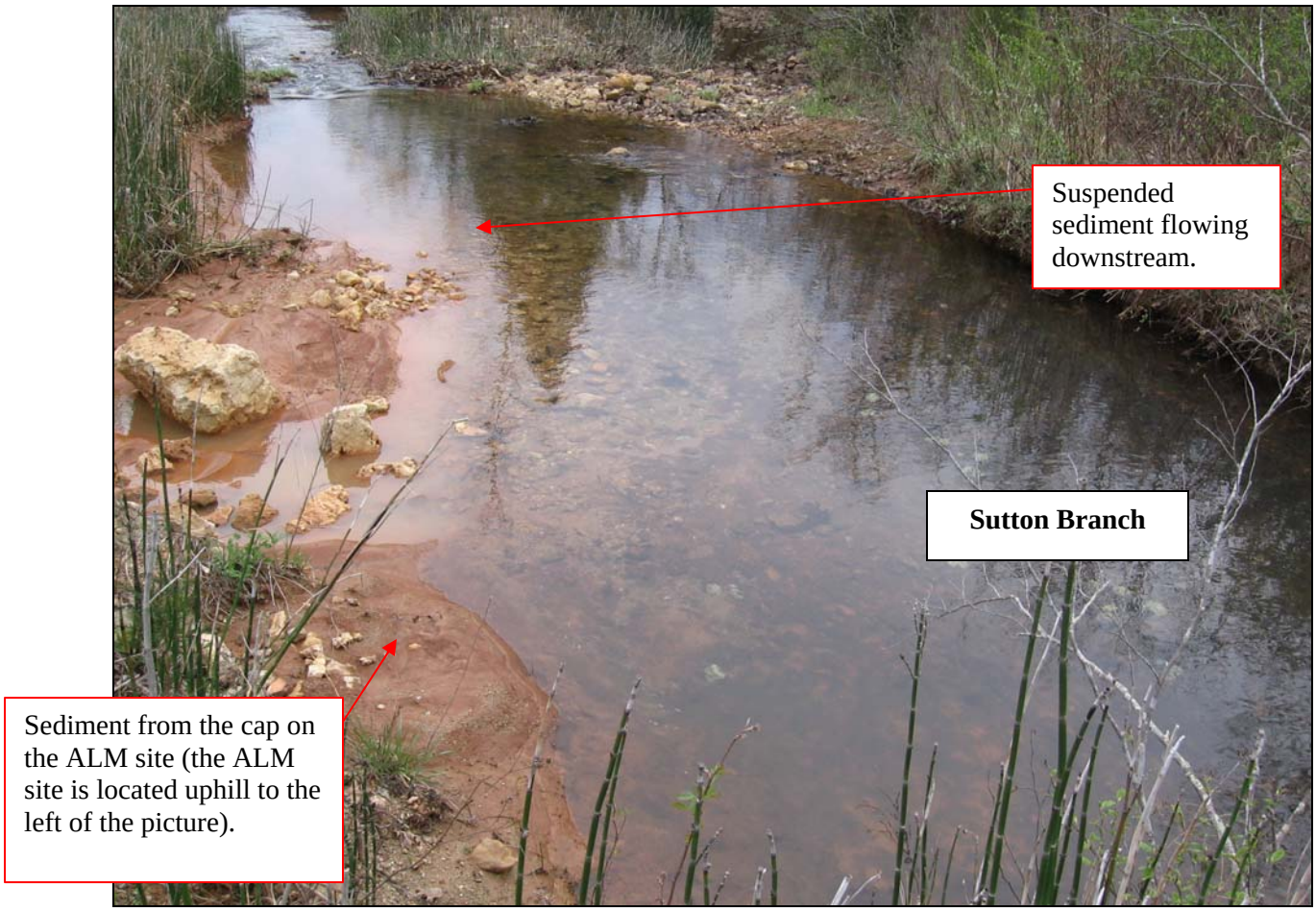
Sutton Branch Area Map, Iron County, Missouri



Modified from: University of Missouri - Columbia BERM (Business Environmental Risk Management) http://ims.missouri.edu/berm/. Sutton Branch and Big Creek have been highlighted in blue. Sutton Branch is classified as an intermittent stream, which may not flow year round.

Figure 2

Point of entry where the ALM site drains into Sutton Branch
Iron County, Missouri



Note: The material visible in the photograph is primarily from the clay cap of the ALM pile; however, the image demonstrates how sediment historically washed into Sutton Branch from the ALM site.